

```

R=1;
L=0.5;
Kt=0.01;
J=0.01;
b=0.1;

num = Kt;
den = [(J*L) (J*R)+(L*b) (R*b)+(Kt^2)];

Ts = 0.12;
[numz,denz] = c2dm(num,den,Ts,'zoh')

```

```

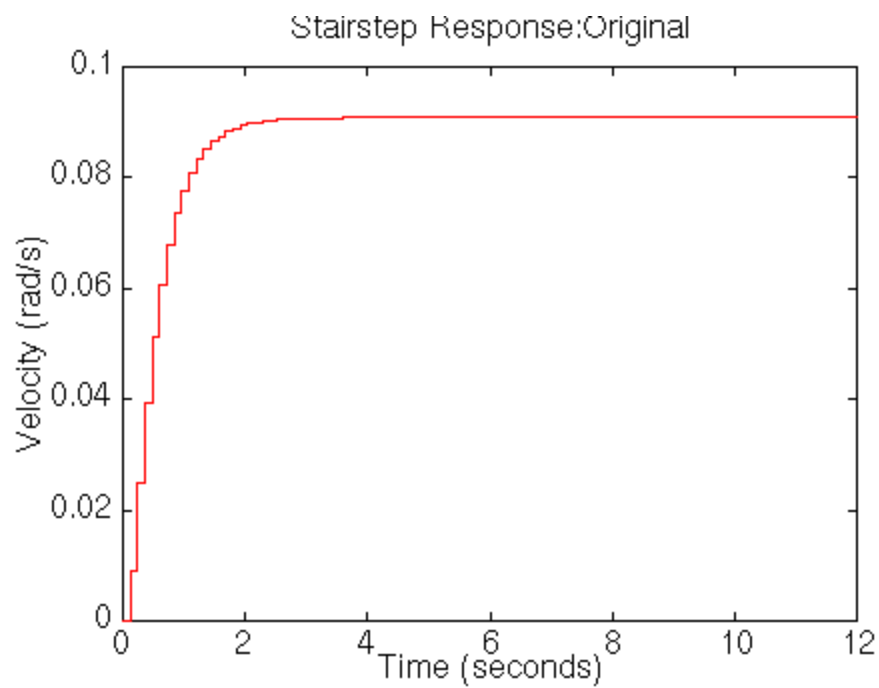
numz = [numz(2) numz(3)];
[numz_cl,denz_cl] = cloop(numz,denz);

```

```

[x1] = dstep(numz_cl,denz_cl,101);
t=0:0.12:12;
stairs(t,x1)
xlabel('Time (seconds)')
ylabel('Velocity (rad/s)')
title('Stairstep Response:Original')

```



PID Controller

$$K_P + \frac{K_I}{s} + K_D s$$

$$\mathbf{z} = \mathbf{e}^{\mathbf{T} \mathbf{s}}$$

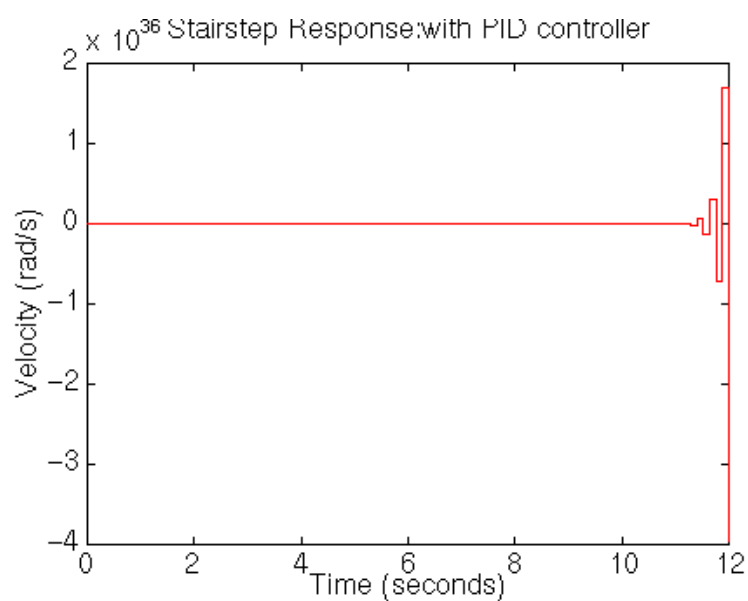
$$s = \frac{2}{T_s} \cdot \frac{z - 1}{z + 1}$$

```
% Discrete PID controller with bilinear approximation
Kp = 100;
Ki = 200;
Kd = 10;
```

```
[dencz,numcz]=c2dm([1 0],[Kd Kp Ki],Ts,'tustin');
```

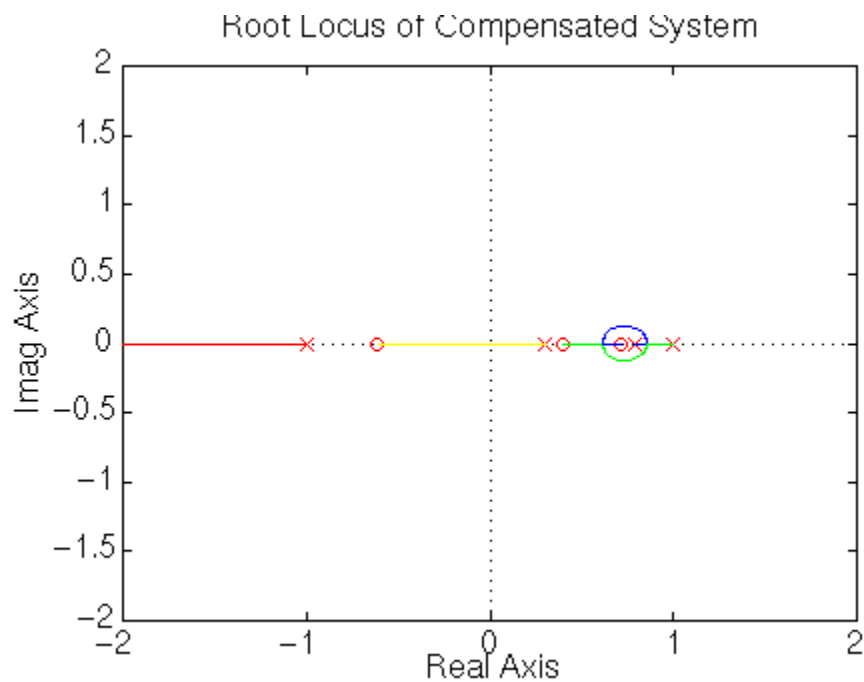
```
numaz = conv(numz,numcz);
denaz = conv(denz,dencz);
[numaz_cl,denaz_cl] = cloop(numaz,denaz);

[x2] = dstep(numaz_cl,denaz_cl,101);
t=0:0.12:12;
stairs(t,x2)
xlabel('Time (seconds)')
ylabel('Velocity (rad/s)')
title('Stairstep Response:with PID controller')
```



```
rlocus(numaz,denaz)
```

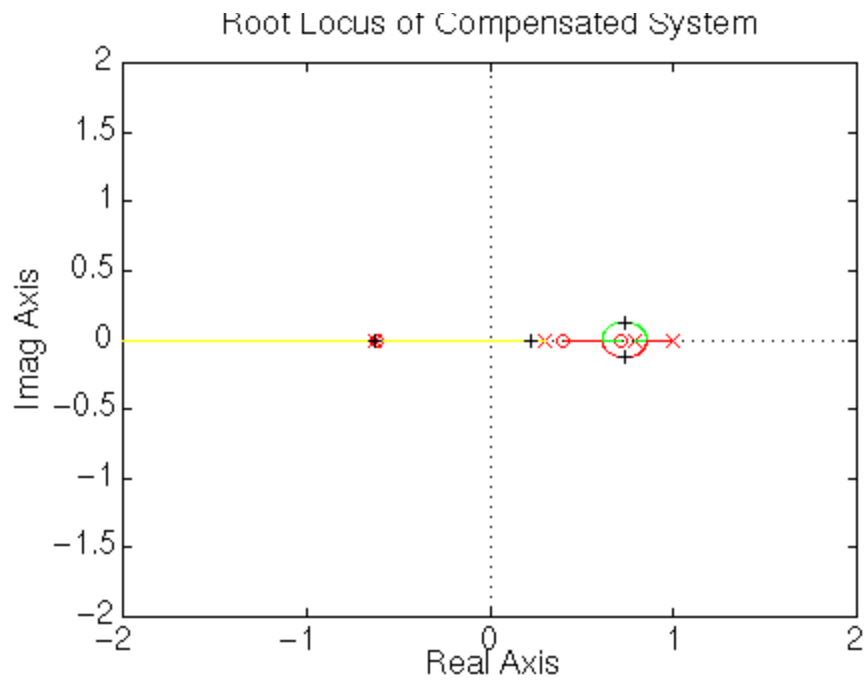
```
title('Root Locus of Compensated System')
```



```
dencz = conv([1 -1],[1.6 1])
numaz = conv(numz,numcz);
denaz = conv(denz,dencz);

rlocus(numaz,denaz)
title('Root Locus of Compensated System');
[K,poles] = rlocfind(numaz,denaz)
[numaz_cl,denaz_cl] = cloop(K*numaz,denaz);

[x3] = dstep(numaz_cl,denaz_cl,101);
t=0:0.12:12;
stairs(t,x3)
xlabel('Time (seconds)')
ylabel('Velocity (rad/s)')
title('Stairstep Response:with PID controller')
```



Then Matlab will return the appropriate gain and the corresponding compensated poles, and it will plot the closed-loop compensated response as follows.

